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(54) **Film having a good adhesive property and process for producing it**

(57) A film having a good adhesive property comprises a base film and a coated layer formed on at least one surface of the base film. The coated layer has carboxylic acid and primary groups such that, at a surface thereof, the concentration of the carboxylic acid groups is not less than 0.005 and the concentration of the primary amine groups is not less than 0.0015.

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## Description

**[0001]** The present invention relates to a film having a good adhesive property and a process for producing it, and more specifically to a film having a good adhesive property which is excellent in adhesive property with a deposited layer, with a particularly good adhesive property under conditions of high moisture content, especially with a printing ink, and which is suitable as a film used for packaging materials, electric insulating materials and other general industrial materials, and a process for producing such a film having a good adhesive property.

**[0002]** US-A-4888381 discloses polyester films coated with a copolyester composition which optionally contains, additionally, any of melamine-formaldehyde, urea-formaldehyde, benzoguanamine-formaldehyde, glycoluril-formaldehyde, epoxy and aziridine resins in an amount of 0 to 40% based on the weight of the polyester. The copolyester may have an acid value from 3-20. The composition renders the polyester film receptive to a variety of surface finishes. Primer coatings, for general use, containing a copolyester composition and melamine formaldehyde resins are disclosed in US-A-4459401 and US-A-4752532.

**[0003]** As a method for providing adhesion between a printing ink or a deposited layer and a base film, a method of applying a corona discharge treatment, a method of blending a low-crystallinity polyester and a high-crystallinity polyester (for example, JP-B-SHO 64-10188), and a method of forming an under-coating layer for a printing ink layer or a deposited layer using a urethane resin, an acrylic resin or a copolymerized polyester resin are known.

**[0004]** In such conventional technologies, however, a sufficient adhesive property or processing property has not been obtained by any of these methods. For example, in a case where a deposited film is used as a package film, any of various films, for example, a heat seal film is laminated on the surface of the deposited layer via a good adhesive layer (a layer having a good adhesive property), and the laminated film is used in package formation. In such a case, there is a problem in that the laminated film is easily delaminated at an interface between the base film and the deposited layer when the laminated film is placed in water. Furthermore, a similar problem arises on application to such films of printing ink.

**[0005]** Accordingly, it would be desirable to provide a film having a good adhesive property which is excellent in adhesive property under highly moist conditions, particularly, in adhesive property with a deposited layer in water, as well as excellent in adhesive property with printing ink and in a finished printed state, and a process for producing it.

**[0006]** As a result of considerable investigation and research into finding a coated layer provided on a base film as an under-coating layer for printing ink or deposited layer, we found that an excellent adhesive property with a printing ink and a deposited layer can be realized by providing on a base film a coated layer having a specified constitution.

**[0007]** A film having a good adhesive property according to the present invention comprises a base film, and a coated film layer formed on at least one surface of the base film.

**[0008]** The coated film layer may be formed, for example, from a composition comprising (a) at least one of a polyester (which may be a graft of an acrylic polymer on a polyester) and an acrylic polymer and (b) a melamine compound.

**[0009]** This application is divided out of an application published as EP-A-0731130, which discloses, as a first aspect of the invention, a coated film layer formed from a composition comprising a mixture of film forming constituents, which mixture comprises (a) a polyester resin and (b) a melamine compound. Preferably, at least 50% by weight of the mixture of film forming constituents consists of the polyester resin (a) and melamine compound (b). It is also preferred that at least 60% by weight of the mixture of film forming constituents forming the coated layer is the polyester resin (a).

**[0010]** According to the present invention, referred to in EP-A-0731130 as a second aspect of the invention, a coated film layer formed on at least one surface of a base film has carboxylic acid and primary amino groups such that, at a surface thereof, the concentration of the carboxylic acid groups is at least 0.005 and the concentration of the primary amine groups is at least 0.0015.

**[0011]** Preferably, in a film according to the invention the coated layer fulfils the requirements of each of the first and second aspects of the invention as defined in EP-A-0731130.

**[0012]** According to a process aspect, the present invention provides a process which comprises the steps of applying a coating composition on at least one surface of a base film which has not yet been oriented and crystallized; and orienting and crystallizing the base film bearing the coated layer by stretching the base film with the coated layer in at least one direction and heat treating it, the constitution of the coating composition and the conditions of heat treatment being such as to provide a coated layer film having carboxylic acid and primary amine groups and in which, at a surface thereof, the concentration of carboxylic acid groups is at least 0.005 and the concentration of primary amine groups is at least 0.0015.

**[0013]** In the above-described films having a good adhesive property, an excellent adhesive property with a deposited layer under highly moist conditions, particularly, with a deposited layer in water, can be obtained, and an excellent adhesive property with a printing ink also can be obtained.

**[0014]** Further objects, features, and advantages of the present invention will be understood from the following more detailed description of preferred embodiments of the present invention.

**[0015]** In preferred embodiments of the present invention, although the material of the base film is not particularly

restricted, it is preferably a polyester film composed of a polyester resin composition. The polyester of such a polyester film may be any polymer whose main chain is composed of ester bonding. As a polyester used in the present invention, polyethylene terephthalate, polyethylene 2,6-naphthalate, polybutylene terephthalate and polyethylene  $\alpha,\beta$ -bis(2-chlorophenoxy)ethane-4,4'-dicarboxylate are particularly preferred. Among these, polyethylene terephthalate and polyethylene 2,6-naphthalate are preferred from the viewpoint of quality and economy, and particularly polyethylene terephthalate is preferred. Therefore, hereinafter, the present invention will be explained with reference to polyethylene terephthalate (hereinafter, referred to as "PET") as a typical polyester.

**[0016]** PET has a repeated unit of ethylene terephthalate at a content of not less than 70 mol%, preferably not less than 80 mol%, more preferably not less than 90 mol%. As long as this condition is maintained, at least one other dicarboxylic component and/or diol component may be copolymerized, as long as the properties of the film are not unduly impaired. For example, polyethylene terephthalate copolymerized with isophthalic acid can be employed.

**[0017]** Furthermore, a generally used additive such as a thermal stabilizer, oxidation inhibitor, weather resistance stabilizer, ultraviolet absorbent, organic lubricant, pigment, dye, organic or inorganic particles, filler and seed agent may be added, again as long as the properties of the film are not unduly impaired.

**[0018]** Moreover, in order to improve the handling ability and processing ability of the film according to the present invention, it is preferred that particles having a mean particle diameter of 0.1 to 10 $\mu$ m selected freely from internally formed particles (i.e. particles formed during, or added for the purpose of, polyester formation) and externally added particles (i.e. particles blended with the polyester or with a starting material for producing it) such as inorganic particles and/or organic particles are present in the base film at a content of 0.01 to 10% by weight, and more preferably, internally formed particles, inorganic particles and/or organic particles having a mean particle diameter of 0.1 to 5 $\mu$ m are present at a content of 0.01 to 3% by weight.

**[0019]** As a method for precipitating internally formed particles, known methods such as those disclosed in JP-A-SHO 48-61556, JP-A-SHO 51-12860, JP-A-SHO 53-41355 and JP-A-SHO 54-90397 can be employed. Furthermore, other particles can be used together as disclosed in JP-A-SHO 55-20496 and JP-A-SHO 59-204617. Use of particles having a mean particle diameter more than 10 $\mu$ m is not preferred because defects in the film are liable to occur. As the inorganic particles and/or organic particles used, for example, inorganic particles such as wet or dry silica particles, colloidal silica particles, titanium oxide particles, calcium carbonate particles, calcium phosphate particles, barium sulfate particles, alumina particles, mica, kaolin and clay and organic particles such as particles comprising styrene, silicone and acrylic acid can be employed. Among these particles, particularly, inorganic particles such as wet and dry colloidal silica particles and alumina particles, and organic particles such as particles comprising styrene, silicone, acrylic acid, methacrylic acid, polyester or divinylbenzene are preferred. Two or more kinds of internally formed particles, inorganic particles and/or organic particles may be used together.

**[0020]** In the present invention, the center line average roughness Ra of the surface of the film after formation of a coated layer is preferably in the range of 0.005 to 0.08 $\mu$ m, more preferably in the range of 0.008 to 0.06 $\mu$ m. Furthermore, the ratio of maximum roughness Rt to center line average roughness Ra "Rt/Ra" is preferably in the range of 10 to 50, and by this, the handling ability, the processing ability and the adhesive property can be all improved. If Rt/Ra is less than 10, the handling ability is liable to be decreased and the film is likely to be damaged. If Rt/Ra is more than 50, partial absence of a deposited layer or an ink layer is liable to occur or the handling ability is liable to decrease because of excessive slipping property, and further the adhesive property may also decrease. Furthermore, with respect to the other surface on which a coated layer is not formed, the handling ability and processing ability thereof can be increased by controlling the surface roughness within the above-described range.

**[0021]** The intrinsic viscosity of the above-described polyester film determined in orthochlorophenol at 25°C is preferably in the range of 0.40 to 1.20 dl/g, more preferably in the range of 0.50 to 0.85 dl/g, and such a polyester film is suitable for use in the present invention.

**[0022]** Furthermore, from the viewpoint of improvement of adhesive property with a coated layer, the content of carboxylic end groups of a polyester film which is a base film for the coated layer is preferably not less than 37 eq/t, more preferably not less than 400 eq/t.

**[0023]** In a PET film using the above-described PET, preferably the film is biaxially oriented in a condition where a coated layer is laminated. The biaxially oriented PET film may be made by stretching a non-stretched PET sheet or film at a stretching ratio of 2.5 to 5 times in the longitudinal and transverse directions, respectively, so as to provide a biaxially oriented pattern in a wide angle X-ray diffraction.

**[0024]** The thickness of the PET film is not particularly restricted, and it may be selected freely depending upon the intended use thereof, but it is preferably in the range of 0.1 to 1,000 $\mu$ m, more preferably in the range of 0.5 to 500 $\mu$ m.

**[0025]** In the present invention, it is necessary that a coated layer is formed on at least one surface of a base film. As a resin coated on the surface of a base film, for example, a polyester resin or an acrylic resin can be used. From the viewpoint of coating on a PET film and thermal resistance, it is preferred that the coated resin contains a polyester resin.

**[0026]** Furthermore, it is preferred that not less than 60% by weight, preferably not less than 80% by weight, of the mixture of film forming constituents forming the coated layer is the polyester resin.

**[0027]** As a method for forming a coated layer, a method for coating a resin on a surface of a base film such as laminating melt-extrusion, hot-melt coating, or in-line or off-line coating using a solvent other than water, a resin soluble in water and/or a resin dispersible in water, or a method for laminating a material having a similar composition or a blended material on a surface of a base film, can be employed. Among these methods, an inline-coating method for applying a coating material on at least one surface of a base film before finishing of orientation and crystallization, stretching the film in at least one direction, heat treating the film, and thereby finishing the orientation and the crystallization thereof is preferred from the viewpoint of formation of a uniform coated layer and industrial production. Such an in-line coating can be performed using a known method, and is not particularly restricted. It is preferred that a surface treatment such as corona discharge treatment is performed before the coating from the viewpoint of adhesion of the coating material to the base film.

**[0028]** A polyester resin forming a coated layer in the present invention is a resin having an ester bond in the main chain or the side chain, and such a polyester resin can be selected freely from known polyester resins. As to the acid component, a dicarboxylic acid containing a sulfonic group such as sulfoisophthalic acid, 5-sulfoisophthalic acid, 2-sulfoisophthalic acid, 4-sulfoisophthalic acid or 4-sulfonaphthalene-2,6-dicarboxylic acid is preferred from the viewpoint of adhesive property. The content of sulfonic group is preferably not more than 0.5 mol%. If sulfonic groups are present to a content more than 0.5 mol%, not only the adhesive property with a deposited layer under high humidity conditions or in water decreases but also the solvent resistance decreases. As a carboxylic acid component which does not contain a sulfonic group, aromatic, aliphatic or cycloaliphatic dicarboxylic acid or polyfunctional carboxylic acid of not less than trivalent acid can be used. As such an aromatic dicarboxylic acid, terephthalic acid, isophthalic acid, orthophthalic acid or 2,6-naphthalene dicarboxylic acid can be used. The content of such an aromatic dicarboxylic acid is preferably not less than 30 mol%, more preferably not less than 35mol% and still more preferably not less than 40 mol% relative to the total dicarboxylic acid component. If the content is less than 30 mol%, the mechanical properties and the water resistance of the polyester copolymer decrease. As the aliphatic and cycloaliphatic dicarboxylic acids, succinic acid, adipic acid, sebacic acid, dodecanedioic acid, dimer acid, 1,3-cyclopentane dicarboxylic acid, 1,2-cyclohexane dicarboxylic acid or 1,4-cyclohexane dicarboxylic acid can be used.

**[0029]** As the glycol component, ethylene glycol, diethylene glycol, polyethylene glycol, propylene glycol, polypropylene glycol, 1,3-propanediol, 1,3-butanediol, 1,4-butanediol, 1,5-pentanediol, 1,6-hexanediol, 1,7-heptanediol, 1,8-octanediol, 1,9-nonanediol, 1,10-decanediol, 2,4-dimethyl-2-ethylhexane-1,3-diol, neopentyl glycol, 2-ethyl-2-butyl-1,3-propanediol, 2-ethyl-2-isobutyl-1,3-propanediol, 3-methyl-1,5-pentanediol, 2,2,4-trimethyl-1,6-hexanediol, 1,2-cyclohexane dimethanol, 1,3-cyclohexane dimethanol, 1,4-cyclohexane dimethanol, 2,2,4,4-tetramethyl-1,3-cyclobutanediol, 4,4'-(2-norbornylidene)diphenol, 4,4'-dihydroxybiphenol, o-, m- and p-dihydroxybenzene, 4,4'-isopropylidene phenol, 4,4'-isopropylidene bndiol, cyclopentane-1,2-diol, cyclohexane-1,2-diol and cyclohexane-1,4-diol can be used.

**[0030]** As the polyfunctional dicarboxylic acid, for example, trimellitic acid, trimellitic anhydride, pyromellitic acid, pyromellitic anhydride, 4-methylcyclohexane-1,2,3-tricarboxylic acid, trimesic acid, 1,2,3,4-butanetetracarboxylic acid, 1,2,3,4-pentanetetracarboxylic acid, 3,3',4,4'-benzophenonetetracarboxylic acid, 5-(2,5-dioxotetrahydrofurfuryl)-3-methyl-3-cyclohexene-1,2-dicarboxylic acid, 5-(2,5-dioxythiotetrahydrofurfuryl)-3-cyclohexene-1,2-dicarboxylic acid, cyclopentanetetracarboxylic acid, 2,3,6,7-naphthalenetetracarboxylic acid, 1,2,5,6-naphthalenetetracarboxylic acid, ethylene glycol bistrimellitate, 2,2',3,3'-diphenyltetracarboxylic acid, thiophene-2,3,4,5-tetracarboxylic acid and ethylenetetracarboxylic acid can be used. Among these, trimellitic acid, pyromellitic acid and 5-(2,5-dioxotetrahydrofurfuryl)-3-methyl-3-cyclohexene-1,2-dicarboxylic acid are preferably used.

**[0031]** In particular, trimellitic acid is preferred from the viewpoint of adhesive property, dispersion in water, solution in water and thermal resistance, and, in particular, trimellitic acid is preferably present to a content of 1 to 25 mol% in a polyester resin. If the content is more than 25 mol%, the film formation of the coated layer becomes unstable, and if the content is less than 1 mol%, the above advantages can hardly be obtained.

**[0032]** The glass transition temperature of a polyester resin forming a coated layer is preferably in the range of 0°C to 80°C. If less than 0°C, the thermal resistance is insufficient, and if more than 80°C, the stretching property of the coated layer deteriorates.

**[0033]** In the present invention, the acid value of a polyester resin forming a coated layer is preferably not less than 20 KOH mg/g, more preferably not less than 25 KOH mg/g. If less than 20 KOH mg/g, a good adhesive property under highly moist conditions, particularly good adhesive property with a deposited layer in water, might not be achieved.

**[0034]** In the present invention, an acrylic resin can also be used for a coated layer. The acrylic resin can be selected freely from known acrylic resins. Such an acrylic resin can be produced by a known method, and the monomer component thereof can be as follows, but the monomer component is not particularly restricted. For example, an acrylic resin may have a basic structure provided by polymerization of an acrylic monomer such as an alkylacrylate or an alkylmethacrylate (examples of the alkyl group are a methyl group, an ethyl group, an n-propyl group, an isopropyl group, an n-butyl group, an isobutyl group, a t-butyl group, a 2-ethylhexyl group, a lauryl group, a stearyl group, a cyclohexyl group, a phenyl group and a benzyl group), and this may be copolymerized with monomers having the following functional groups in order to provide a functional group. As such a functional group, a carboxylic group, a methylol group, an acid

anhydride, a sulfonic group, an amide group or an alkylol-modified amide group, an amino group (including a substituted amino group) or an alkylol-modified amino group, a hydroxyl group and an epoxy group can be used, and a salt and an ester compound of these groups may be copolymerized.

**[0035]** As a compound having a carboxylic group or a salt thereof or an acid anhydride, examples which can be used are acrylic acid, methacrylic acid, itaconic acid, maleic acid, fumaric acid, crotonic acid and an alkali metallic salt, an ammonium salt or an anhydride of these carboxylic acids.

**[0036]** As a compound having an amide group or an alkylol-modified amide group, examples which can be used are acrylic amide, methacrylic amide, N-methylmethacrylic amide, methylol-modified acrylic amide, methylol-modified methacrylic amide, ureidovinylether,  $\beta$ -ureidoisobutylvinylether and ureidoethylacrylate.

**[0037]** As a compound having an amino group or an alkylol-modified amino group, examples which can be used are diethylaminoethylvinylether, 2-aminoethylvinylether, 3-aminopropylvinylether, 2-aminobutylvinylether, dimethylaminoethylmethacrylate, dimethylaminoethylvinylether, and a compound which is prepared by modifying the amino group of these compounds to a methylol or a compound which is prepared by modifying these compounds to a tetrasalt by an alkyl halide, dimethyl sulfate or sulfone.

**[0038]** In the present invention, as a melamine compound forming a coated layer, examples which can be used are melamine, a methylol modified melamine derivative prepared by condensation of melamine and formaldehyde, a compound partially or completely etherified by reaction of a lower alcohol to a methylol modified melamine, and a mixture thereof. A melamine resin which can be used may be either a monomer or a condensate of a polymer comprising a dimer or more, and furthermore, a mixture thereof may be employed. As a lower alcohol used for the etherification, examples which can be used are methylalcohol, ethylalcohol, isopropylalcohol, n-butanol and isobutanol.

**[0039]** Although a compound prepared by partially etherifying a methylol modified melamine derivative and a mixture thereof is preferred in the present invention, the compound to be used is not particularly restricted by this.

**[0040]** In the present invention, the melamine based compound is present preferably to a content of 0.01 to 30% by weight of the film forming constituents forming a coated layer, more preferably to a content of 0.05 to 20% by weight. If less than 0.01% by weight, the advantage of improvement of adhesive property might not be obtained. If more than 30% by weight, the stretching property of the coated layer may become poor and a stable coated layer may be difficult to form.

**[0041]** In a film according to the present invention, the coated layer has carboxylic acid groups and the concentration of the carboxylic acid groups at a surface of the coated layer is not less than 0.005. It is more preferably in the range of 0.006 to 0.20, still more preferably in the range of 0.007 to 0.050. If it is less than 0.005, the desired adhesive property may become poor. On the other hand, the adhesive property may also decrease if the concentration is too great.

**[0042]** As a method for achieving a concentration of the carboxylic acid groups at a surface of a coated layer of not less than 0.005, any method for coating a resin having a large amount of carboxylic acid in an end or side chain of the resin at a surface of a base film can be employed, for example, laminating melt-extrusion, hot-melt coating, or in-line or off-line coating using a solvent other than water, a resin soluble to water and/or a resin dispersible in water, or a method for laminating a material having a similar composition of a blended material on a surface of a base film.

**[0043]** As a method for obtaining a resin having a large amount of carboxylic acid in an end or side chain of the resin, a method for preparing such a resin from a resin copolymerized with a polyfunctional carboxylic acid having an acid value of three or more, for example, as disclosed in JP-A-SHO 54-46294, JP-A-SHO 60-209073, JP-A-SHO 62-240318, JP-A-SHO 53-26828, JP-A-SHO 53-26829, JP-A-SHO 53-98336, JP-A-SHO 56-116718 and JP-A-SHO 61-124684, can be employed. Further, although a method other than these methods may be employed, polyester resins aforementioned which can form a coated layer may be preferred.

**[0044]** In a film according to the present invention, the coated layer has primary amine groups and the concentration of the primary amine group at a surface of the coated layer is not less than 0.0015. It is preferably not less than 0.00155, more preferably not less than 0.0016. If it is less than 0.0015, the adhesive property under highly moist conditions may become poor.

**[0045]** The method for obtaining a concentration of a primary amine groups of not less than 0.0015 on at least one surface is not particularly restricted as long as this condition can be satisfied, so any method for coating a resin having a large amount of an amine in an end or side chain of the resin (and/or a resin capable of creating amine groups by treatment such as heat treatment) on a surface of a base film can be employed, for example, laminating melt-extrusion, hot-melt coating, or in-line or off-line coating using a solvent other than water, a resin soluble to water and/or a resin dispersible in water, or a method for laminating a material having a similar composition or a blended material on a surface of a base film. As the resin coated on the surface, a urea-based, melamine-based, acrylic amide-based or polyamide-based compound and methylol modified or methylmethanol modified compounds thereof can be used. Although such a compound is not particularly restricted, a melamine-based compound is preferred from the viewpoint of coating on a PET film, thermal resistance, application property and adhesive property. Furthermore, if the above-described melamine compound is added, the content thereof in a coated layer is preferably in the range of 0.01 to 30% by weight, more preferably in the range of 0.05 to 20% by weight, from the viewpoint of film formation.

[0046] A method for achieving a concentration of carboxylic acid groups of not less than 0.005 and a concentration of primary amine groups of not less than 0.0015 at the surface of a coated layer, is to blend a polyester resin or an acrylic resin and an amide compound or a melamine compound. However, the method is not particularly restricted by this method.

[0047] In the present invention, in a case where a coated layer is formed by a polyester resin and a melamine compound, the polyester resin (A) and the melamine compound (B) can be blended at a freely selected ratio. The ratio (A)/(B) by weight is preferably in the range of 99/1 to 60/40, more preferably in the range of 99/1 to 80/20, and still more preferably in the range of 99/1 to 90/10. In this case, a part of, or the whole of the polyester resin and the melamine compound may or may not be reacted. In a case where either a polyester resin or a melamine compound is not present, the adhesive property under highly moist conditions, particularly the adhesive property with a deposited layer in water, becomes insufficient.

[0048] In the present invention, although a coating material forming a coated layer may be applied on a biaxially oriented polyester film, it is preferred that the coating material is applied on a polyester film before finishing of orientation and crystallization and thereafter the coated film is dried, stretched and heat treated to finish the orientation and crystallization, namely, the coated layer is formed in a process for producing a biaxially oriented polyester film, to minimise formation of pinholes in an ink layer or a deposited layer due to sticking of dust or foreign materials in the process and so that a thin coated layer can be uniformly formed. In a case where a coated layer is formed by this method, it is preferred that a water base resin advantageous as being explosion proof and reducing environmental contamination is used, and it is preferred that a water-soluble resin and/or a water-dispersible resin is used as the above-described resin. A water soluble organic compound or a surface active agent may be used together for the water-soluble resin and/or the water-dispersible resin, and a resin made by a known method can be freely used.

[0049] Although the thickness of the coated layer is not particularly restricted, generally it is in the range of 0.001 to 1 $\mu$ m, preferably in the range of 0.005 to 0.3 $\mu$ m, more preferably in the range of 0.01 to 0.1 $\mu$ m, and particularly preferably in the range of 0.02 to 0.07 $\mu$ m. If the coated layer is too thick, a layer deposited thereon may be whitened and glossiness thereof decreased when applied with heat at about 200°C. If the coated layer is too thin, the adhesive property may decrease. Furthermore, the above-described range in thickness is preferred also from the viewpoint of recovery where the film is processed into chips and they are reused.

[0050] A layer of a coating material forming a coated layer is preferably applied in a process for manufacturing a biaxially oriented polyester film as described above, and in a case where a plurality of coating material layers are laminated in such a process, the adhesive property with a deposited layer, the glossiness of the formed coated layer and the adhesive property with an ink are all excellent, and therefore such a process is particularly preferred. Further, various additives such as organic or inorganic particles, lubricant, antistatic agent, weather resistant agent, thermal resistant agent, dye and pigment may be added in the coated layer as long as the desired properties are not unduly impaired.

[0051] A metal layer or a metal oxide layer may be provided on the above-described coated layer by a known deposition process. As a deposited metal, a single material such as gold, silver, aluminium, silicon, palladium, nickel, cobalt, zinc, tin, titanium or indium, or a mixed metal compound thereof, or an oxide thereof can be used.

[0052] A process for producing a preferred film embodying the invention will now be explained below.

[0053] After PET containing so-called internally formed particles precipitated in the polymerization process and inorganic particles (for example, silica particles having a mean particle diameter of 1 $\mu$ m) and having an intrinsic viscosity of 0.63 dl/g is dried by a regular method, it is melt-extruded, and a sheet-like molten material delivered out is cooled and solidified on a cooling drum to prepare a non-oriented PET film. The film is heated at a temperature of 80 to 120°C while the film is stretched in the longitudinal direction at a draw ratio of 1:1 to 5.0 times to make a uniaxially oriented PET film. A corona discharge treatment is applied on one surface of the uniaxially oriented PET film, and on the treated surface, a coating resin (e.g. polyester)/melamine compound water mixing-system coating material is applied so as to control the thickness to a predetermined thickness. The method for application is not particularly restricted, and for example, a method using a rod coater, a gravure coater, a reverse coater or a roll coater can be employed. This film coated with the coating material is introduced into a tenter heated at a temperature of 90 to 140°C while held by clips, and after or during drying, the film is stretched in the transverse direction at a draw ratio of 2.5 to 5.0 times and continuously heat treated in a heat treatment zone controlled at a temperature of 160 to 250°C for a time of 1 to 10 seconds. During this heat treatment, as needed, a relaxation treatment may be performed at a relax of 0 to 12%. Thus, a polyester film provided with a coated layer formed from a mixture whose main constituents are a polyester resin and a melamine compound can be obtained.

[0054] Next, methods for determining the characteristics in the present invention and estimating the effects according to the present invention will be explained.

(1) Amount of carboxylic end group:

[0055] This was determined based on the method of Maurice A 2g sample of polymer was dissolved in 50ml.

o-cresol/chloroform (weight ratio: 7/3), it was titrated using N/20-NaOH methanol solution, and the amount of carboxylic end group was determined as a value of eq/polyester  $10^6$ g (that is, ton).

(2) Acid value (KOH mg/g):

**[0056]** The acid value was determined based on JIS-K3504. Namely, the amount of potassium hydroxide (mg) required to neutralize an acid contained in a 1g sample was determined.

(3) Parameter of surface roughness:

**[0057]** The parameter of surface roughness was measured using a high-accuracy level difference measuring apparatus for a thin film (ET-10 produced by Kosaka Kenkyusyo Corporation).  $R_a$  is the center line average height, and  $R_t$  is the maximum height and is represented by the distance between the highest and deepest peaks in the roughness curve. The measuring conditions were as follows, and the mean value of 20 measurements was defined as the parameter of surface roughness.

- Radius of the tip of probe : 0.5 $\mu$ m
- Load of the probe : 5mg
- Measuring length : 1mm
- Cut off : 0.08mm

**[0058]** An explanation of the respective parameters is given in, for example, "Method for determining and estimating surface roughness" by Jiro Nara (Sogo Gijutsu Center, 1983). Moreover, the meanings of  $R_a$  and  $R_t$  are defined in JIS-B-0601 and ISO-468-1982 ( $R_t$  is represented as  $R_{max}$  in the JIS and as  $R_y$  in the ISO).

(4) Concentration of carboxylic acid at surface:

**[0059]** The concentration of carboxylic acid was determined under the following conditions using "ESCA-750" produced by Shimadzu Seisakusyo Corporation.

- Excited X-ray : MgK $\alpha$  1,2 ray (1253.6 eV)
- Photoelectron emission angle  $\theta$  : 90°

**[0060]** Polyacrylic acid (PAA) was used as the standard sample. For both the standard sample and the measuring samples, the following gaseous chemical reaction was performed.

**[0061]** The sample films and the PAA film, which was the standard sample, were cut at a size of about 1cm square, respectively, and the carboxylic acid present at their film surfaces was esterified by trifluoroethanol (TFE) using pyridine and dicyclohexylcarbodiimide (DCC) as the catalyst in an atmosphere of air in a desiccator. (The sample films and the PAA film were treated in an identical batch.)

**[0062]** The reaction rate (r) with TFE and the residual rate (m) of DCC used as the reaction catalyst were determined from the PAA standard sample, and the concentration of carboxylic acid at the surface of each sample film (-COOH/C [total]) was determined in consideration of "r" and "m" for the peak areas of  $C_{1s}$  and  $F_{1s}$  of each sample film.

(5) Concentration of primary amine at surface:

**[0063]** The concentration of primary amine was determined under the following conditions using "ESCA-750" produced by Shimadzu Seisakusyo Corporation.

- Excited X-ray : MgK $\alpha$  1,2 ray (1253.6 eV)
- Photoelectron emission angle  $\theta$  : 90°

**[0064]** Diaminophenylether (DADPE) was used as the standard sample. For both the standard sample and the measuring samples, the following gaseous chemical reaction was performed.

**[0065]** The sample films and the DADPE film, which was the standard sample, were cut to a size of about 1cm square, respectively, and the amino groups present at their film surfaces were reacted with pentafluorobenzaldehyde (PFB) in an atmosphere of air in a desiccator. (The sample films and the DADPE film were treated in an identical batch).

**[0066]** The reaction rate (r) with PFB was determined from the DADPE standard sample, and the concentration of primary amine at the surface of each sample film (-NH<sub>2</sub>/C [total]) was determined in consideration of "r" for the peak

areas of  $N_{1s}$  and  $F_{1s}$  of each sample film.

(6) Adhesive property for deposited layer:

- 5 [0067] A1 metal was deposited on the surface of the coated layer of a sample film using an electron beam heating type deposition apparatus so that the thickness of the deposited layer was in the range of 400 to 500Å. Thereafter, a non-stretched polypropylene film (CPP) (thickness: 50μm, "T3501" produced by Toray Gosei Film Corporation) was bonded on the deposited film using a polyurethane-based adhesive, and after the film was left in an atmosphere at a temperature of 40°C for 48 hours, it was cut to a width of 15 mm. The delamination at an angle of 180° of the CPP and  
10 the deposited layer in the cut film was performed using a tensile tester and the delamination strength was measured at a delamination speed of 10 cm/min. The adhesive property for the deposited layer was determined by this delamination strength. In a case where the delamination strength between the deposited layer and the coated layer is great, the delamination occurred at the interface between the CPP and the deposited layer. The delamination strength was determined in dry conditions (25°C and 50%RH) and wet conditions (to determine waterproof adhesive property) under  
15 which water was dropped into the delamination interface.

(7) Adhesive property for printing ink:

- 20 [0068] After nitrocellulose-based ink "CCST" produced by Toyo Ink Corporation was printed on the surface of the coated layer of a sample film using a gravure roll, the printed film was left in an atmosphere at a temperature of 40°C and a relative humidity (RH) of 90% for 48 hours, and thereafter, the delamination test using a cellophane tape was performed. The standard for estimation is as follows.

- Rank 5: The ink is not delaminated at all.
- 25 • Rank 4: Less than 5% of the ink is delaminated onto the surface of the cellophane tape.
- Rank 3: Not less than 5% and less than 10% of the ink is delaminated onto the surface of the cellophane tape.
- Rank 2: Not less than 10% and less than 50% of the ink is delaminated onto the surface of the cellophane tape.
- Rank 1: Not less than 50% of the ink is delaminated onto the surface of the cellophane tape.

30 (8) Printing suitability:

- [0069] After nitrocellulose-based ink "CCST" produced by Toyo Ink Corporation was printed on the surface of the coated layer of a sample film using a gravure roll, the finish condition was observed and the printing suitability was determined based on the following standard.

- 35 O : Wrinkles and irregularity of printing do not occur.  
X : Wrinkles, irregularity of printing and ink cissing occur.

(9) Thermal resistance:

- 40 [0070] An aluminium deposited film was treated by a heat sealer for one second, and the thermal resistance was determined by observation based on the following standard.

- O : Whitening does not occur at a temperature of not higher than 220°C.  
45 Δ : Whitening does not occur at a temperature of not higher than 215°C.  
X : Whitening occurs at a temperature lower than 215°C.

(10) Stability of coated layer in film formation:

- 50 [0071] A coating material was applied using a rod coater on the film which had been uniaxially stretched and treated with a corona discharge treatment, the coated film was stretched and heat treated in a tenter, and thereafter, the coated layer formed on the film was observed and determined based on the following standard.

- O : There is no irregularity at all.  
55 Δ : There is a slight, but acceptable irregularity.  
X : There are irregularities and cracks. Coating is not uniformly performed.

- [0072] Especially preferred embodiments of the invention will now be explained in more detail with reference to the



following Reference Examples (provided by way of assistance for understanding the Examples), Examples and Comparative Examples. The results of these Examples and Comparative Examples are shown in Tables 1 to 3.

#### Reference Example

**[0073]** After PET pellets (intrinsic viscosity: 0.64 dl/g) containing internally formed particles precipitated in the polymerization process and having a particle diameter of 0.5 to 1.5 $\mu$ m and silica particles having a mean particle diameter of 10 $\mu$ m were sufficiently vacuum dried, the pellets were supplied to an extruder and melt-extruded, and a sheet-like molten material delivered out was cast on a cooling drum with a surface temperature of 30°C and cooled and solidified on the cooling drum. In order to improve the adhesive property between the sheet and the drum in this process, a wire electrode was disposed on the sheet side and a DC voltage of 6000V was applied to the electrode. The non-stretched PET film thus obtained (amount of carboxylic end group: 42 eq/t) was heated at 95°C and stretched in the longitudinal direction at a draw ratio of 3.5 times to prepare a uniaxially stretched film. A corona discharge treatment was performed on one surface of the film in the atmosphere, and a coating material prepared as follows was applied on the surface treated by the corona discharge treatment using a rod coater. The application thickness was controlled so that the thickness after finishing of orientation and crystallization was 0.05 $\mu$ m.

**[0074]** Composition of coating materials - Dispersion in water of:

- Polyester resin A (acid value: 41 KOH mg/g, glass transition temperature (T<sub>g</sub>) : 20°C) : 85 parts by weight containing the following components as the acid component;

|                   |               |
|-------------------|---------------|
| terephthalic acid | : 29 mol%,    |
| isophthalic acid  | : 7 mol%,     |
| trimellitic acid  | : 10 mol%,    |
| sebacic acid      | : 3 mol%, and |

containing the following components as the glycol component;

|                  |           |
|------------------|-----------|
| ethylene glycol  | : 14 mol% |
| neopentyl glycol | : 19 mol% |
| 1,4-butanediol   | : 18 mol% |

- N-methylol modified melamine component (MW-12LF, produced by Sanwa Chemical Corporation) : 15 parts by weight (solid component ratio)  
(solids content adjusted to provide required coating thickness).

**[0075]** The uniaxially stretched PET film coated with the coating material was introduced into a tenter heated at a temperature of 110°C while held by clips, and after water component had been removed by drying, the film was stretched in the transverse direction at a draw ratio of 3.5 times in a zone of the tenter heated at 120°C, and further, the film was heat treated in an atmosphere controlled at 225°C for five seconds to obtain a polyester film having a thickness of 12 $\mu$ m and a coated layer thickness of 0.05 $\mu$ m.

**[0076]** The results of determination of the adhesive property for a deposited layer, the adhesive property for a printing ink, the printing suitability, etc., showed that excellent properties could be obtained (see Table 1).

#### Example 1

**[0077]** A polyester film having a film thickness of 12 $\mu$ m and having a good adhesive coated layer with a thickness of 0.05 $\mu$ m was obtained in a manner similar to that of the Reference Example, except that the mixing ratio of the polyester resin A and the N-methylol modified melamine compound used in Example 1 in the coating material was changed to 95/5. In the surface of the coated layer of the obtained polyester film, the concentration of carboxylic acid was 0.013 and the concentration of primary amine was 0.003.

**[0078]** The results of determination of the adhesive property for a deposited layer, the adhesive property for a printing ink, the printing suitability, etc., showed that particularly excellent properties could be obtained (see Table 1).

#### Comparative Example 1

**[0079]** A polyester film having a film thickness of 12 $\mu$ m and having a good adhesive coated layer with a thickness of 0.05 $\mu$ m was obtained in a manner similar to that of Example 1, except that the polyester resin A was changed to a

polyester resin B having an acid value of 10 KOH mg/g. In the surface of the coated layer of the obtained polyester film, the concentration of carboxylic acid was 0.004 and the concentration of primary amine was 0.003.

[0080] The results of determination of the adhesive property for a deposited layer, the adhesive property for a printing ink, the printing suitability, etc., showed that good properties could be obtained (see Table 2).

#### Comparative Example 2

[0081] A polyester film having a film thickness of 12  $\mu\text{m}$  and having a good adhesive coated layer with a thickness of 0.05  $\mu\text{m}$  was obtained in a manner similar to that of Example 1, except that the mixing ratio of the polyester resin A and the N-methylol modified melamine compound used in Example 1 in the coating material was changed to 99/1. In the surface of the coated layer of the obtained polyester film, the concentration of carboxylic acid was 0.017 and the concentration of primary amine was 0.0005.

[0082] The results of determination of the adhesive property for a deposited layer, the adhesive property for a printing ink, the printing suitability, etc., showed that good properties could be obtained (see Table 2).

#### Example 2

[0083] A polyester film having a film thickness of 12  $\mu\text{m}$  was obtained in a manner similar to that of Example 1, except that the thickness of the coated layer of Example 1 was changed to 0.1  $\mu\text{m}$ . In the surface of the coated layer of the obtained polyester film, the concentration of carboxylic acid was 0.015 and the concentration of primary amine was 0.003.

[0084] The result of determination of the adhesive property for a deposited layer, the adhesive property for a printing ink, the printing suitability, etc., showed that excellent properties could be obtained (see Table 1).

#### Example 3

[0085] A polyester film having a film thickness of 12  $\mu\text{m}$  and having a good adhesive coated layer with a thickness of 0.07  $\mu\text{m}$  was obtained in a manner similar to that of the Reference Example, except that the polyester resin A used in Example 1 was changed to an acrylic graft polyester resin and the mixing ratio of the acrylic graft polyester resin and the N-methylol modified melamine compound used in Example 1 in the coating material was set at 95/5. In the surface of the coated layer of the obtained polyester film, the concentration of carboxylic acid was 0.015 and the concentration of primary amine was 0.0025.

[0086] The results of determination of the adhesive property for a deposited layer, the adhesive property for a printing ink, the printing suitability, etc., showed that excellent properties could be obtained (see Table 1).

#### Comparative Example 3

[0087] A biaxially oriented PET film was obtained in a manner similar to that of the Reference Example, except that a coated layer was not provided. The results of determination of the obtained film (see Table 2) showed that the waterproof adhesive property was quite poor, and not only it was easily delaminated from the interface between PET and A1 but the adhesive property for printing ink was also poor.

#### Comparative Example 4

[0088] A polyester film was obtained in a manner similar to that of the Reference Example, except that a coated layer was formed only from the following acrylic resin B. In the surface of the coated layer of the obtained polyester film, the concentration of carboxylic acid was 0.017 and the concentration of primary amine was 0.

[0089] The results of determination of the adhesive property for a deposited layer, the adhesive property for a printing ink, the printing suitability, etc., showed that the waterproof adhesive property was quite poor and the adhesive property for printing ink was also poor (see Table 2).

- Acrylic resin B : MMA/BA/AA/AN copolymerized acrylic

MMA : methylmethacrylate  
BA : butylacrylate  
AA : acrylic acid  
AN : acrylonitrile

Table 1

|                   | Adhesive property for deposited layer(g/15mm) |                              | Adhesive property for ink | Printing suitability | Thermal resistance | Stability of coated layer |
|-------------------|---|------------------------------|---------------------------|----------------------|--------------------|---------------------------|
|                   | dry   | Waterproof adhesive property |                           |                      |                    |                           |
| Reference Example | 350   | 140                          | 4                         | O                    | O                  | O                         |
| Example 1         | ≥ 500   | ≥350                         | 5                         | O                    | O                  | O                         |
| Example 2         | ≥500  | 300                          | 5                         | O                    | O                  | O                         |
| Example 3         | 345   | 140                          | 4                         | O                    | Δ                  | O                         |

Table 2

|                       | Adhesive property for deposited layer(g/15mm) |                              | Adhesive property for ink | Printing suitability | Thermal resistance | Stability of coated layer |
|-----------------------|---|------------------------------|---------------------------|----------------------|--------------------|---------------------------|
|                       | dry   | Waterproof adhesive property |                           |                      |                    |                           |
| Comparative Example 1 | 350   | 125                          | 4                         | O                    | O                  | O                         |
| Comparative Example 2 | 360   | 115                          | 4                         | O                    | O                  | O                         |
| Comparative Example 3 | ≤30   | ≤30                          | 1                         | X                    |                    |                           |
| Comparative Example 4 | ≤30   | ≤30                          | 1                         | X                    |                    |                           |

**[0090]** As can be seen from the above Examples and Comparative Examples, in a film embodying the present invention, by forming a coated layer controlling the concentration of carboxylic acid to not less than 0.005 and the concentration of primary amine to not less than 0.0015, the adhesive property for a deposited layer under highly moist conditions, particularly in water, and the adhesive property for a printing ink can be remarkably improved.

#### Claims

1. A film comprising a base film and a coated layer film formed on at least one surface of the base film, characterized in that the coated layer film has carboxylic acid and primary amine groups such that, at a surface thereof, the concentration of carboxylic acid groups [COOH/C(total)] is at least 0.005 and the concentration of primary amine groups [NH<sub>2</sub>/C(total)] is at least 0.0015.
2. A film according to claim 1, wherein the base film comprises a polyester resin composition.
3. A film according to claim 1 or 2, wherein 0.01% to 30% by weight of a mixture of film forming constituents forming the coated layer is a melamine compound.
4. A film according to any preceding claim, wherein the coated layer is formed from a mixture of film forming constituents, which mixture is composed of a polyester resin and a melamine compound, and the weight ratio of the polyester resin to the melamine compound in the mixture is in the range of 99/1 to 80/20.

5. A film according to any preceding claim, wherein the coated layer contains a polyester resin, and the polyester resin forming the coated layer has an acid value of at least 20 KOH mg/g.
6. A film according to any preceding claim, wherein the coated layer contains a polyester resin, and the amount of any sulfonic groups contained in a molecule of the polyester resin forming the coated layer is not more than 0.5 mol%.
7. A film according to any preceding claim, wherein the coated layer contains a polyester resin, and the polyester resin forming the coated layer contains a trimellitic acid.
8. A film according to any preceding claim, wherein the coated layer contains a polyester resin, and the glass transition temperature of the polyester resin forming the coated layer is in the range of 0°C to 80°C.
9. A film according to any preceding claim, wherein the thickness of the coated layer is in the range of 0.001 to 1µm.
10. A film according to any preceding claim, wherein the coated layer has a surface, which surface has a surface roughness parameter  $R_t/R_a$  in the range of 10 to 50.
11. A film according to any one of claims 2 to 10, wherein the polyester resin composition forming the base film has a carboxylic acid content of at least 37 eq/t.
12. A film according to any preceding claim, further comprising a layer of a metal or a metal oxide provided on the coated layer.
13. A film according to claim 12, wherein the layer of a metal or a metal oxide is provided by deposition.
14. A film according to any preceding claim, further comprising a layer of an ink provided on the coated layer.
15. Use of a film according to any preceding claim in packaging.
16. A process for producing a film comprising the steps of:
  - applying a coating composition on at least one surface of a base film which has not yet been oriented and crystallized; and
  - orienting and crystallizing the base film bearing the coated layer by stretching the base film with the coated layer in at least one direction and heat treating it,
  - the constitution of the coating composition and the conditions of heat treatment being such as to provide a coated layer film having carboxylic acid and primary amine groups and in which, at a surface thereof, the concentration of carboxylic acid groups is at least 0.005 [COOH/C(total)] and the concentration of primary amine groups is at least 0.0015 (NH<sub>2</sub>/C(total)).
17. A process according to claim 16, wherein the base film comprises a polyester resin composition.
18. A process according to claim 16 or 17, wherein 0.01% to 30% by weight of a mixture of film forming constituents forming the coated layer is a melamine compound.
19. A process according to any one of claims 16 to 18, wherein the coated layer contains a polyester resin, and the polyester resin forming the coated layer has an acid value of at least 20 KOH mg/g.
20. A process according to any one of claims 16 to 19, wherein the coated layer contains a polyester resin, and the amount of any sulfonic group contained in a molecule of the polyester resin forming the coated layer is at least 0.5 mol%.
21. A process according to any one of claims 16 to 20, wherein the coated layer contains a polyester resin, and the polyester resin forming the coated layer contains a trimellitic acid.



European Patent  
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# EUROPEAN SEARCH REPORT

Application Number  
EP 00 12 2851

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| The present search report has been drawn up for all claims   |   |  |  |
| Place of search<br><b>THE HAGUE</b>  |   | Date of completion of the search<br><b>29 January 2001</b>   | Examiner<br><b>Hallemeesch, A</b>            |
| CATEGORY OF CITED DOCUMENTS<br>X : particularly relevant if taken alone<br>Y : particularly relevant if combined with another document of the same category<br>A : technological background<br>O : non-written disclosure<br>P : intermediate document |   | T : theory or principle underlying the invention<br>E : earlier patent document, but published on, or after the filing date<br>D : document cited in the application<br>L : document cited for other reasons<br>& : member of the same patent family, corresponding document |  |

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